

LOW DENSITY COMPOSITE ROCKET NOZZLE
COMPONENTS AND PROCESS FOR MAKING THE SAME ...

Inventors: Allan P. Thompson et al.

Filed: November 25, 2003

Attorney Docket No. 5776.2US

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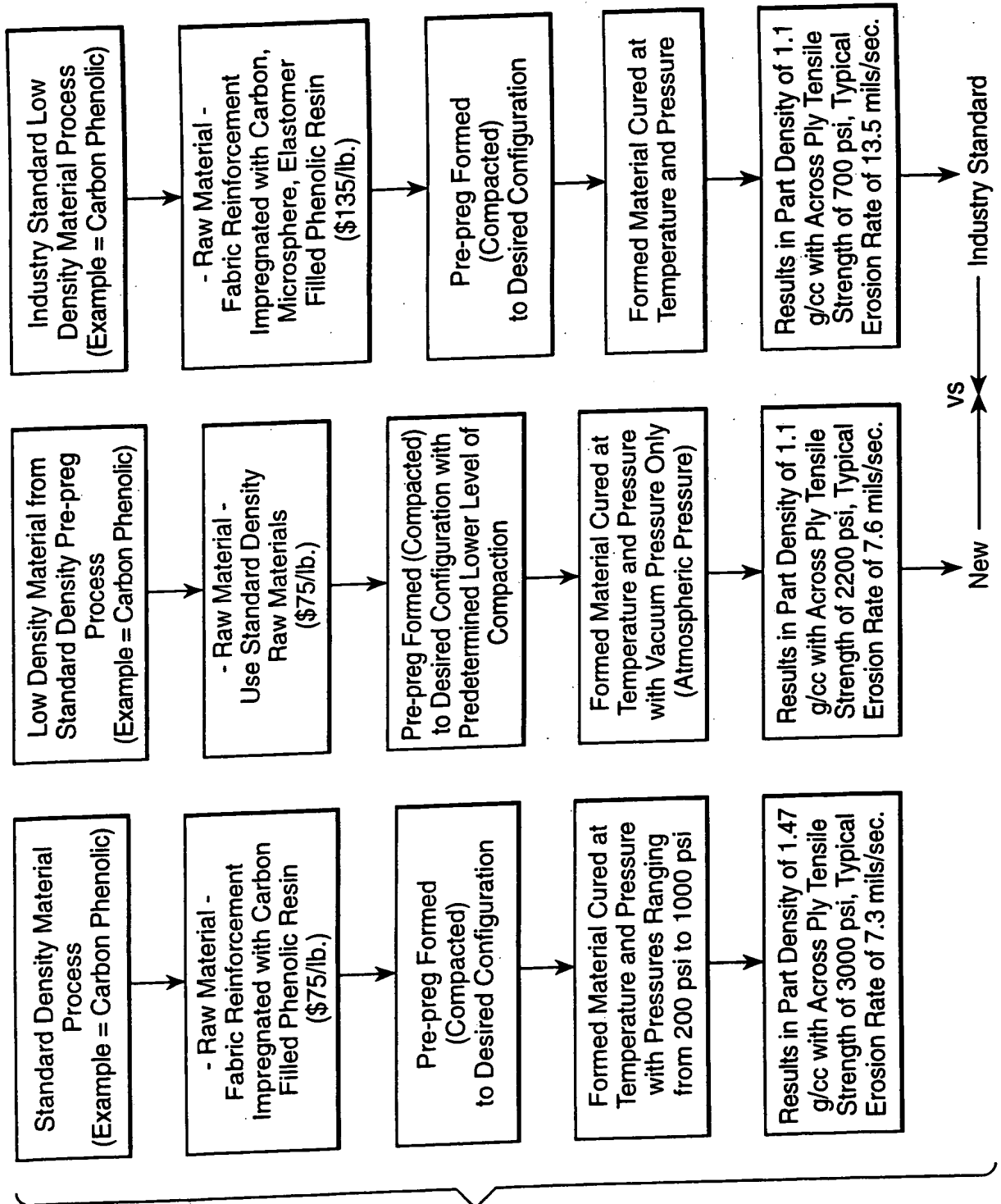
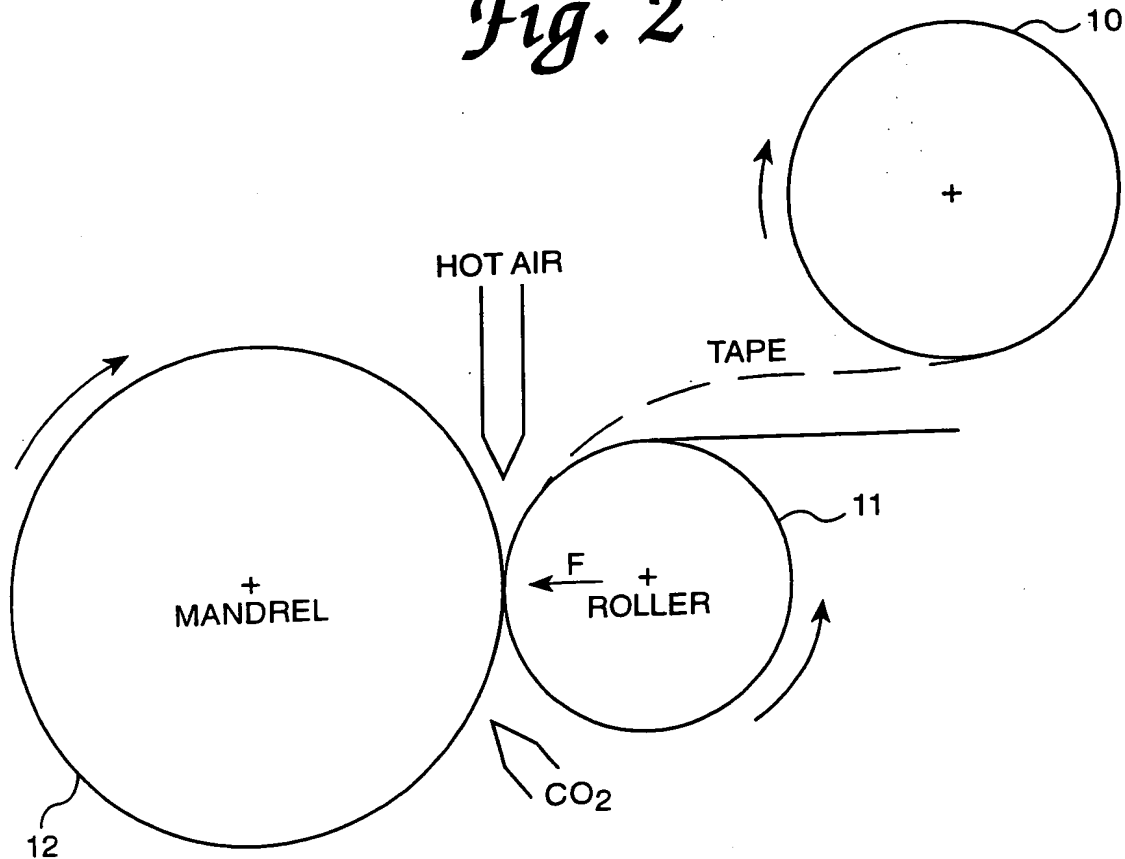


Fig. 1

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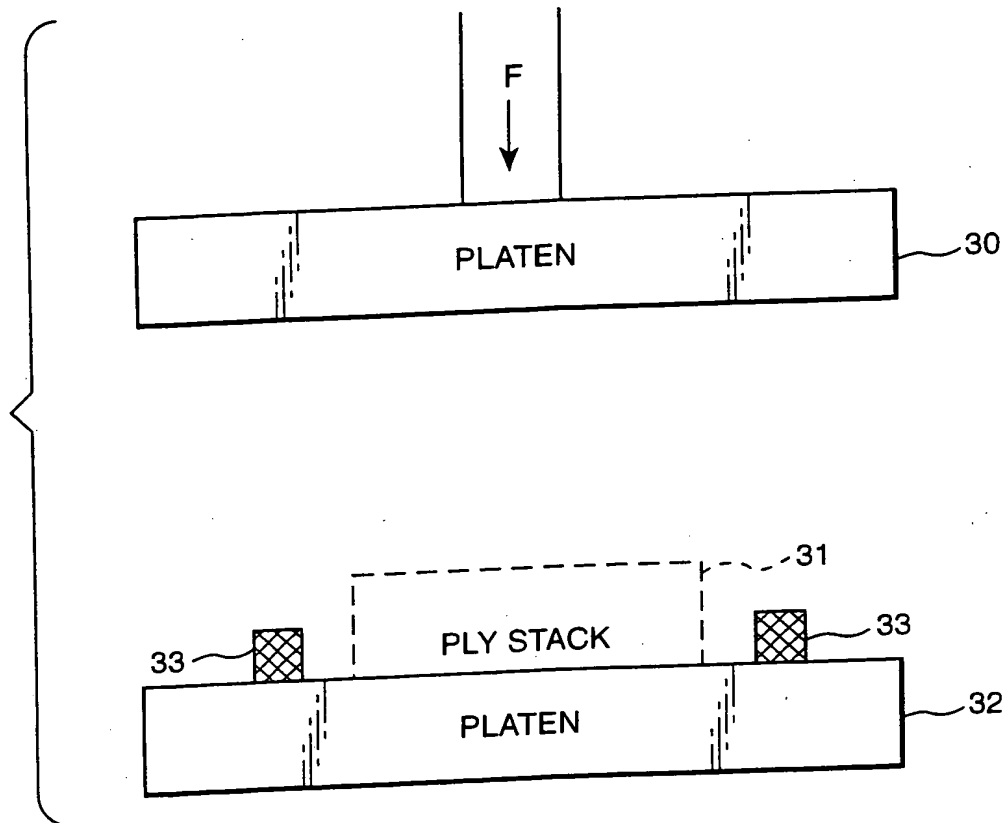
Fig. 2



- A. A wrap mandrel is placed in the machine (a wrap machine looks much like a lathe).
- B. The tape application roller is set parallel to the wrapping surface of the mandrel.
- C. Tape is fed across the surface of the application roller
- Pre-preg tape is heated with hot air as it crosses over the roller to soften the tape.
 - Pressure is applied through the roller to debulk the tape onto the wrap mandrel.
 - CO₂ from a liquid holding tank is applied to cool and harden the debulked tape.

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Fig. 3



- A. A stack of plies is placed in the heated platen press for debulk.
- Platen are warmed to 130 - 150°F to soften pre-preg.
 - Stops are set to restrict platen travel and to achieve desired debulked ply thickness.
- B. Press platen are closed to stops and held at temperature for 20 min.
- C. Debulked stacks are cooled to room temperature before opening platen.
- D. Debulked stacks are stacked to form entire billet.

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Fig. 4A

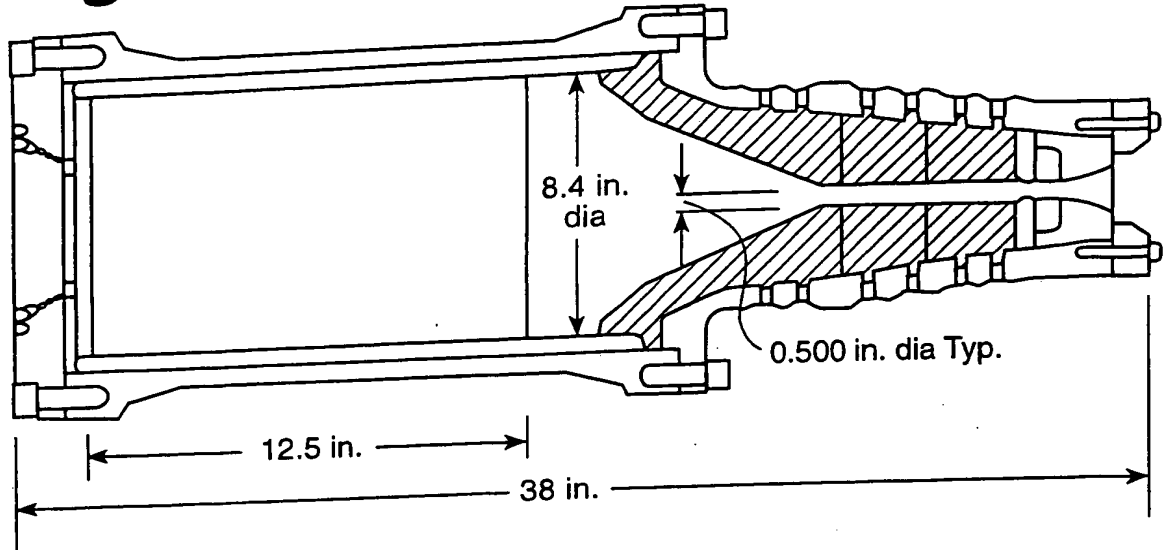


Fig. 4B

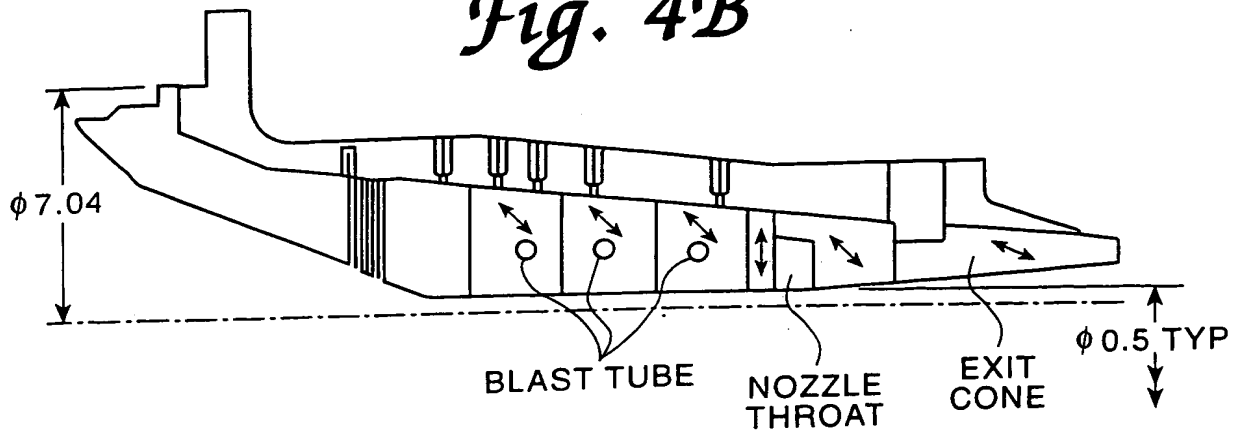
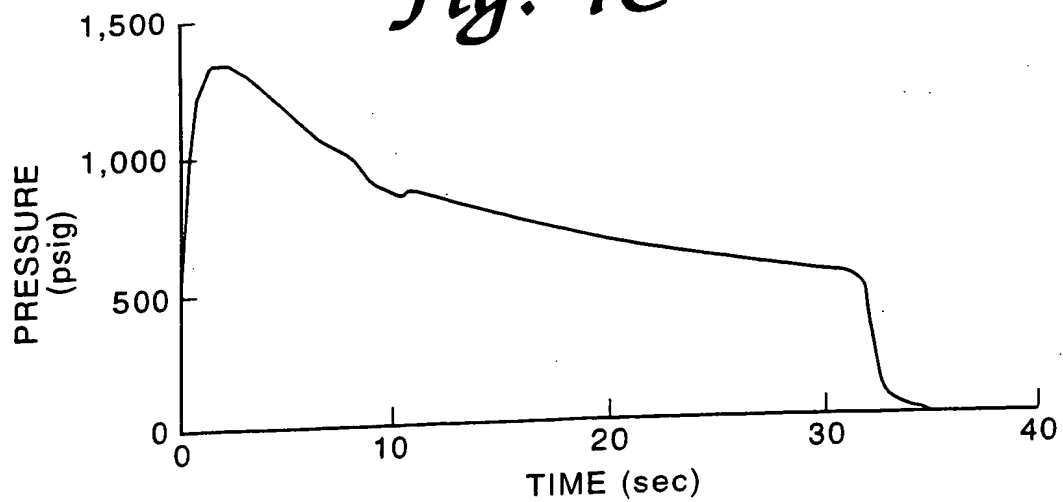


Fig. 4C



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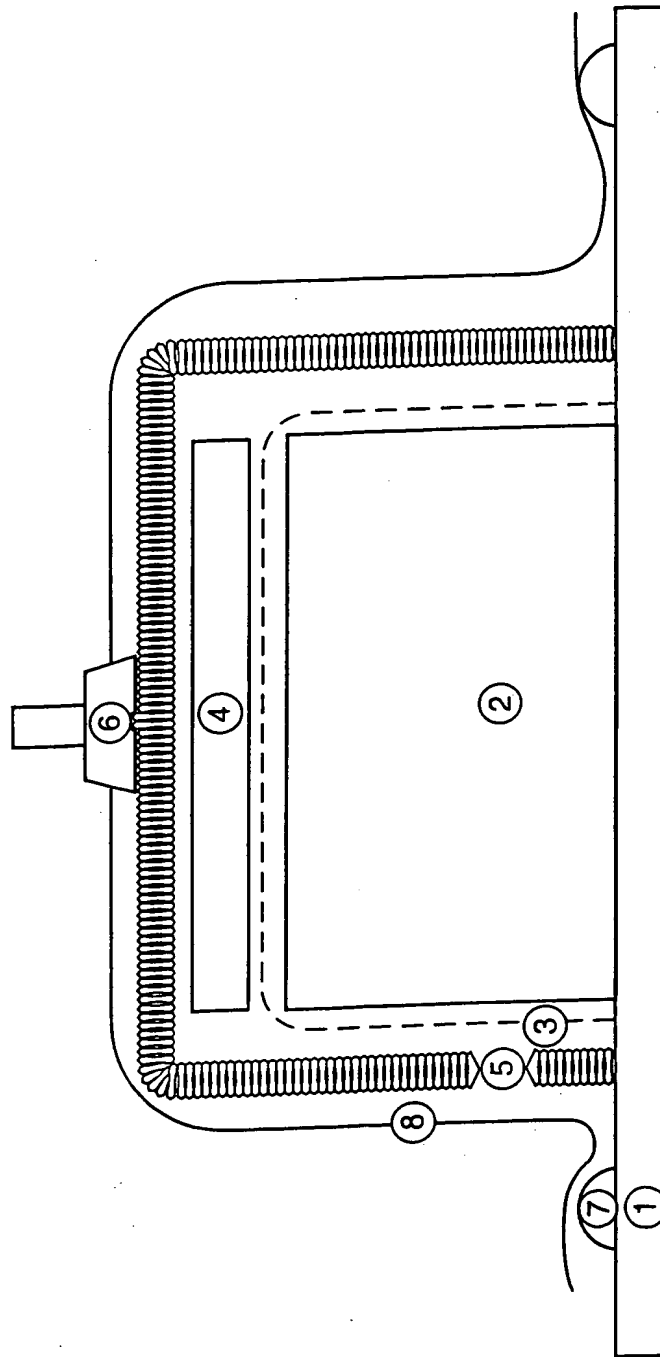
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Fig. 5



- | | |
|--|---------------------------------|
| ① CAUL PLATE | ⑤ MOP TUBING
6 piles maximum |
| ② PLY STACK
(6-8 debulked ply stacks) | ⑥ VACUUM LINE |
| ③ PERFORATED FILM | ⑦ VACUUM PUTTY |
| ④ CAUL PLATE | ⑧ NYLON VACUUM BAG |

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Fig. 6A

Component	Motor	Material	Norm. Erosion, mils/s	Norm. Char. inches	Total Heat Affected Depth, inches
Blast Tube-Aft	MPCE-1	MX-4946	2.39	0.409	0.493
	MPCE-2	MX-4926 VC	7.59	0.268	0.534
	MPCE-3	MX-4920 VC	6.18	0.464	0.680
	MPCE-4	UF MX-134 LDR (1.2)	11.03	0.234	0.620
	MPCE-5	UF MX-4920	5.32	0.483	0.669
	MPCE-6a	FM-32800 LD/LF	12.18	0.255	0.681
	MPCE-6b	MX-4955	8.65	0.398	0.701
	MPCE-7	MX-4946 VC	6.10	0.386	0.599
	MEAN	MX-4926	7.25	0.283	0.537
Blast Tube-Mid	MPCE-1	MX-4946	9.32	0.464	0.790
	MPCE-2	MX-4926 VC	10.49	0.301	0.668
	MPCE-3	MX-4920 VC	6.56	0.761	0.991
	MPCE-4	UF MX-134 LDR (1.2)	15.60	0.299	0.845
	MPCE-5	UF MX-4920	9.28	0.582	0.907
	MPCE-6	FM-32800 LD	13.97	0.205	0.694
	MPCE-7	MX-4946 VC	8.22	0.496	0.784
Blast Tube-Fwd	MPCE-1	MX-4946, 45	5.88	0.278	0.484
	MPCE-2		7.30	0.246	0.502
	MPCE-3		6.16	0.319	0.535
	MPCE-4		7.67	0.244	0.512
	MPCE-5		7.71	0.322	0.592
	MPCE-6		9.16	0.283	0.604
	MPCE-7		6.90	0.288	0.530
	MEAN	MX-4926	7.25	0.283	0.537
Throat	Typical	4D C/C, 1.95 gm/cc	2.50		
	MPCE-1	4D C/C, 1.90 gm/cc	1.20		
	MPCE-2	RTM'd 4D C/C, 1.75 gm/cc	6.12		
	MPCE-3	Compulent Hf/2W	0.81		
	MPCE-4	2D C/C Brake, 1.87 gm/cc	3.98		

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Component	Motor	Material	Norm. Erosion, mils/s	Norm. Char. inches	Total Heat Affected Depth, inches
Throat	MPCE-5	HfC on Poco Graphite ZIRCONIUM DIBORIDE Insitu C/C by PL RD	7.26		
	MPCE-6		7.76		
	MPCE-7		5.01		
Throat Inlet	MPCE-1	MX-4926, 90	6.73	0.341	0.543
	MPCE-2		9.94	0.364	0.678
	MPCE-3		8.97	0.562	0.896
	MPCE-4		7.50	0.617	1.033
	MPCE-5		11.90	0.700	0.963
	MPCE-6		8.76	0.330	0.589
	MPCE-7		7.41		
Forward Exit Cone	MPCE-1	MX-4946, 45	4.24	0.216	0.364
	MPCE-2		4.00	0.260	0.400
	MPCE-3		12.74	0.216	0.682
	MPCE-4		4.62	0.211	0.350
	MPCE-5		3.72	0.340	0.430
	MPCE-6		4.73	0.190	0.356
	MPCE-7		3.42	0.297	0.417
Aft Exit Cone	C4-7	MX-4946	7.65	0.295	0.563
	MPCE-1	MX-4926	4.22	0.193	0.341
	MPCE-2a	MX-4920 VC	3.05	0.219	0.326
	MPCE-2b	MX-4926 VC	5.42	0.269	0.459
	MPCE-3a	UF MX-4920 VC	6.73	0.254	0.677
		UF MX-4920	6.37	0.292	0.991
	MPCE-4a	UF MX-134 LDR (1.2)	4.54	0.272	0.431
	MPCE-4b	UF MX-4920 VC & PC	4.57	0.344	0.504
	MPCE-5a	FM-32800 LD/LF	4.11	0.285	0.429
	MPCE-5b	UF MX-134 LDR (1.2) PC	4.15	0.258	0.400
	MPCE-6a	MX-4926 VC & PC	4.94	0.352	0.525
	MDCE-6b	FM-32800 LD/LF PC	4.93	0.270	0.443
	MPCE-7a	MX-4955 VC	3.24	0.420	0.534
	MPCE-7b	MX-4946 VC	3.42	0.360	0.484

Fig. 6B

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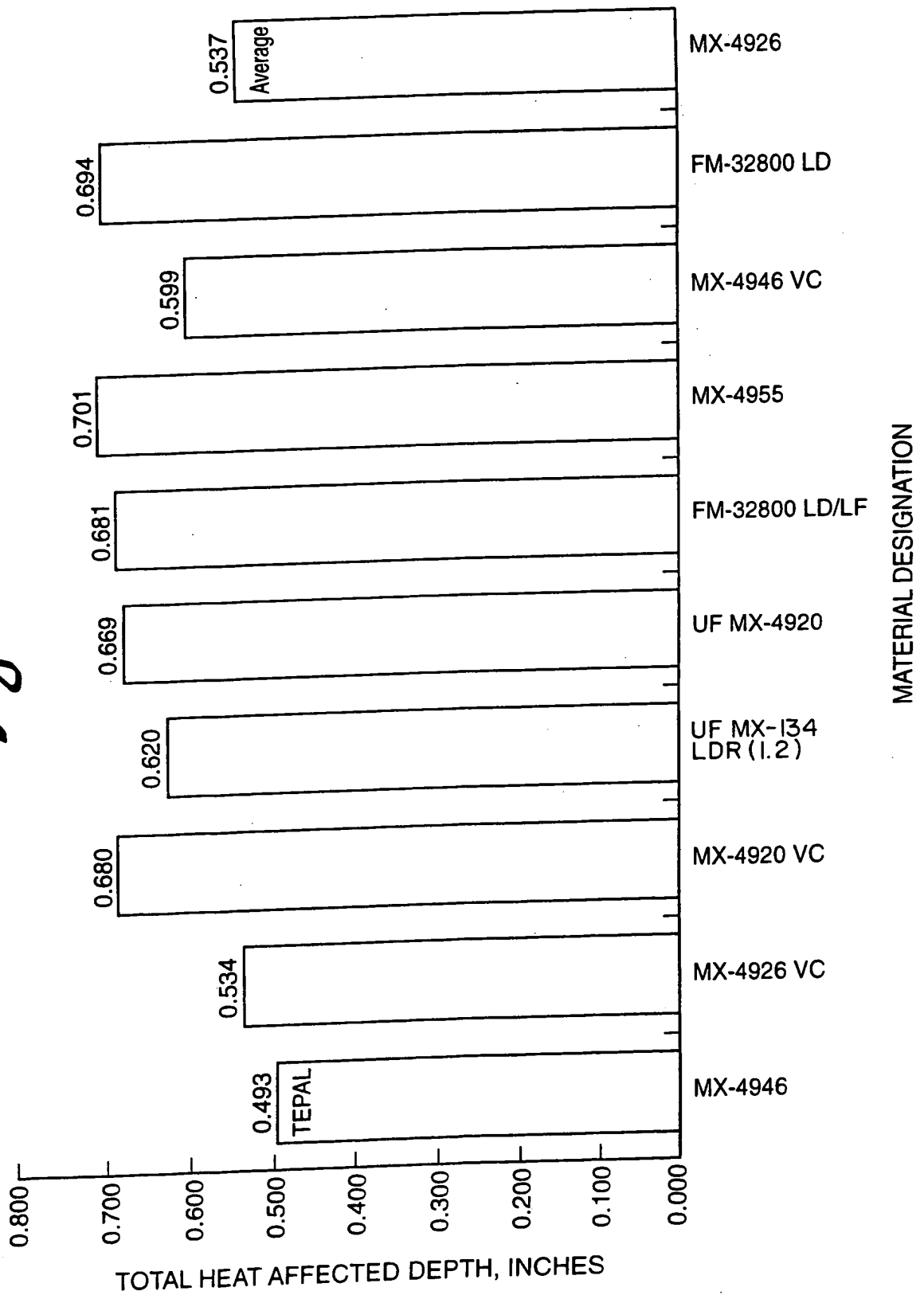
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Fig. 7



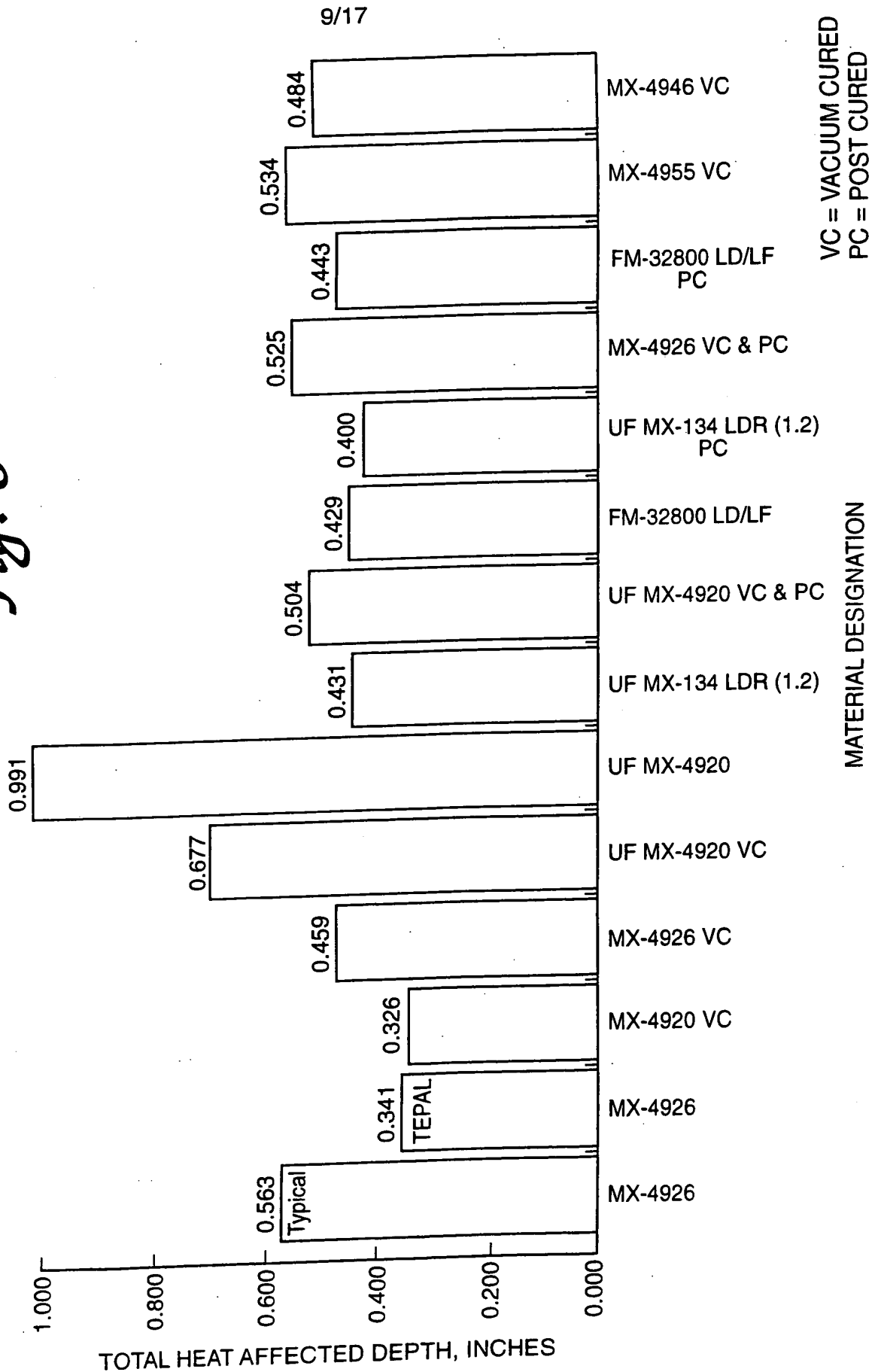
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Fig. 8



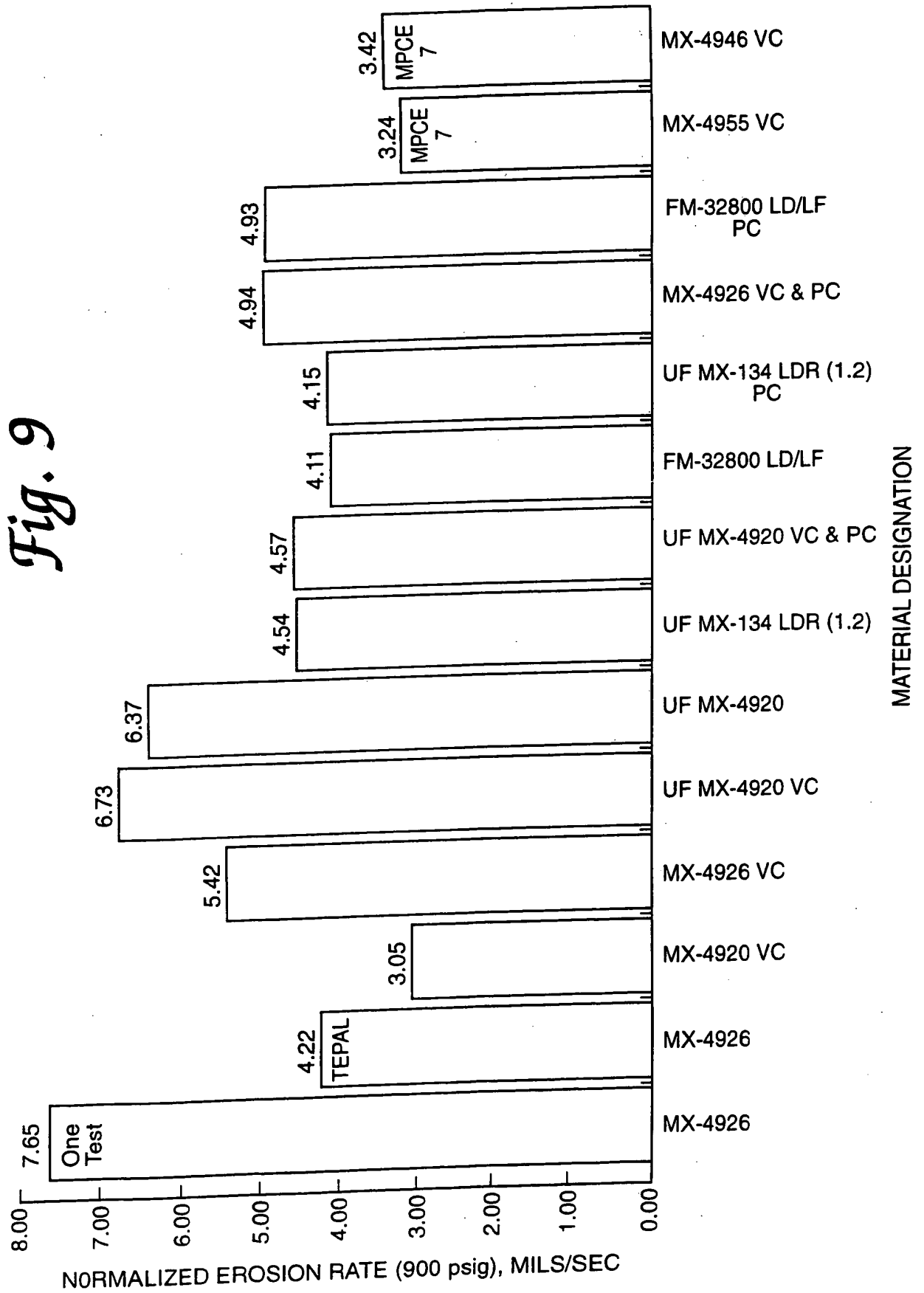
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Fig. 10A

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Fig. 10B

Location	Motor	Material	Bulk Density, gm/cc	Specific Gravity	Residual Volatiles, wt%	Resin Content, wt%	Compressive Strength, psi	Norm. Erosion mils/s	Norm. Char, inches	Thad, inches
Aft Exit Cone	MPCE-1	MX-4946	1.463	1.483	0.65	36.45		4.22	0.193	0.341
	MPCE-2	MX-4926 VC	1.097	1.144	0.39	31.83		5.42	0.269	0.459
		MX-4920 VC	1.424	1.468	0.67	28.01		3.05	0.219	0.326
	MPCE-3	UF MX-4920	1.458	1.504	2.84	28.44	18718	6.73	0.254	0.677
		UF MX-4920 VC	1.368	1.415	1.42	33.73	22534	6.37	0.292	0.991
	MPCE-4	UF MX-134 LDR	1.212	1.243	1.85	40.97		4.54	0.272	0.431
		UF MX-4920 VC/PC	1.324	1.396	0.06	31.66	20583	4.57	0.344	0.504
	MPCE-5	FM-32800 LD/LF	1.098	1.190	0.80	27.45	16646	4.11	0.285	0.429
		UF MX-134 LDR PC	1.212	1.245	2.02	42.29	16759	4.15	0.258	0.400
	MPCE-6	MX-4926 VC/PC	1.084	1.154	0.00	30.93	18195	4.93	0.299	0.525
		FM-32800 LD/LF PC	1.127	1.213	0.46	28.10	7748	4.94	0.365	0.443
	MPCE-7	MX-4955 VC	1.371	1.428	0.17	27.02	16872	3.42	0.398	0.484
		MX-4946 VC	1.323	1.412	0.13	35.44		3.24	0.450	0.534

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Fig. 11

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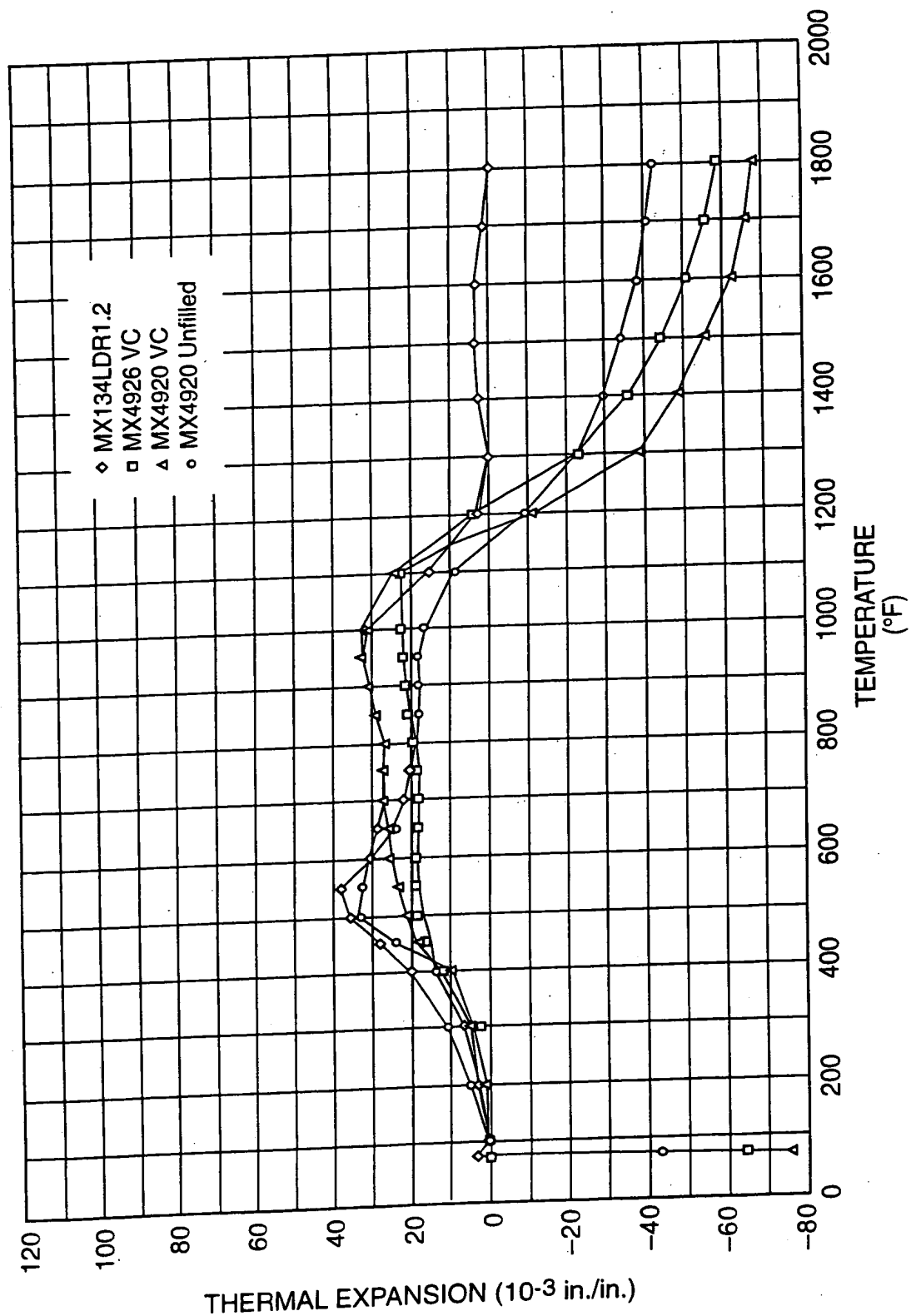
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Fig. 12



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Fig. 13

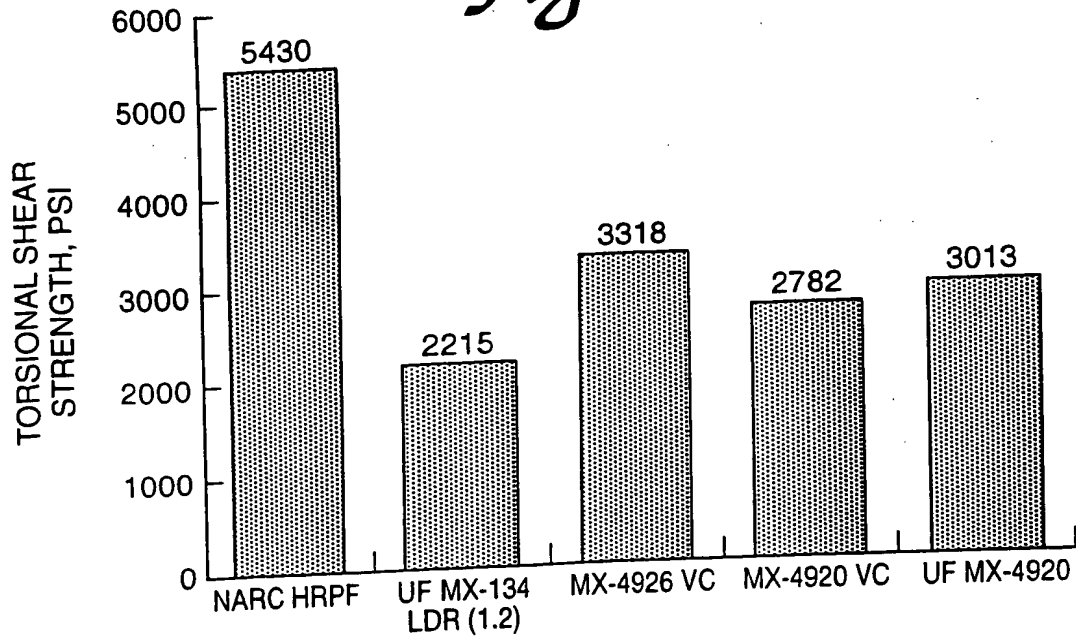
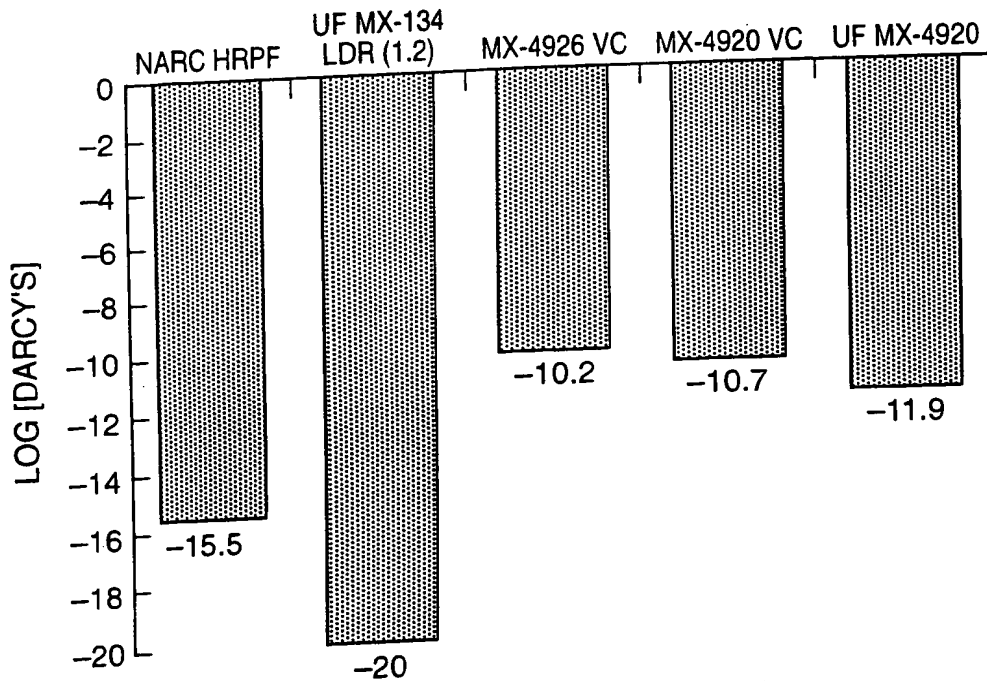


Fig. 14



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Fig. 15

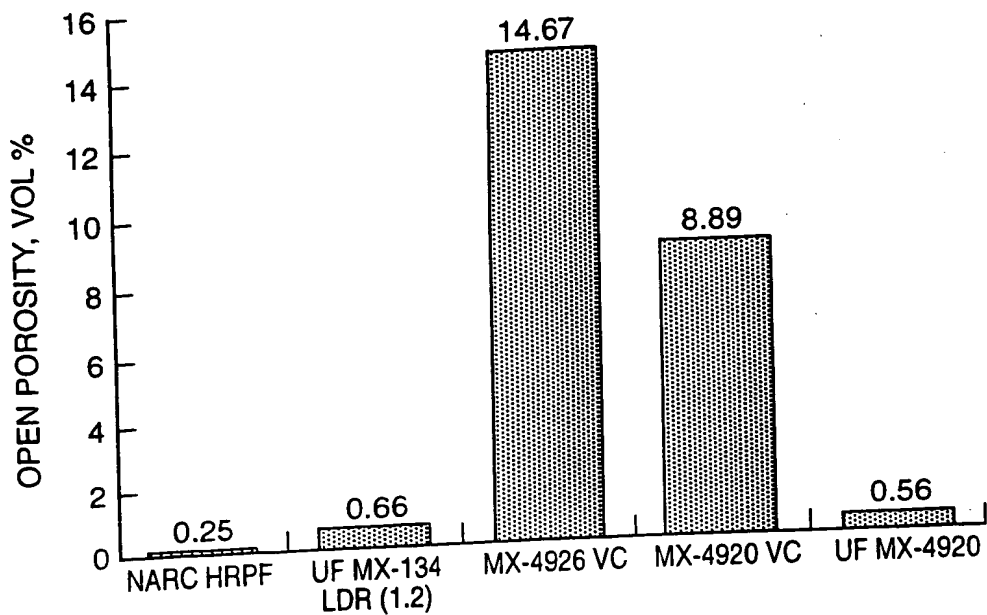
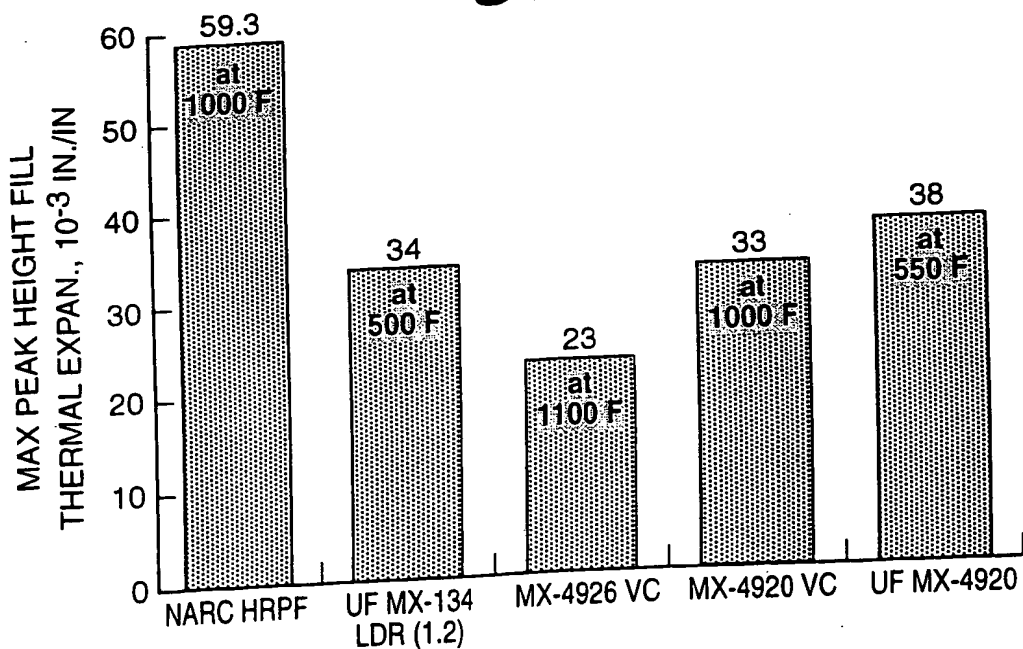


Fig. 16



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Fig. 17

